POPULATION CHARACTERISTICS OF HUMPBACK WHALES IN GLACIER BAY AND ADJACENT WATERS: 1992

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ABSTRACT

Sixty-eight different humpback whales (*Megaptera novaeangliae*), including 12 calves (17.6%) were identified in Glacier Bay and Icy Strait between May 20 and September 2, 1992. Of these whales, 17 (25%) were seen solely in Glacier Bay, while 33 (48.5%) were seen only in Icy Strait. Eighteen whales (26.5%) were common to both areas. 18 (51.4%) of the Glacier Bay whales and 28 (54.9%) of Icy Strait whales were resident for greater than 20 days. The peak of whale use of Glacier Bay occurred in July and August, with the most activity concentrated in Bartlett Cove, Sitakaday Narrows and the Beardslee Entrance. Although many Glacier Bay whales practiced solitary, sub-surface feeding, groups of 3 to 6 whales were frequently observed in the mouth of Bartlett Cove at the peak of the season. Foraging patterns in Icy Strait were similar, with most whales foraging alone or in pairs, with typically only one larger group in the area. An eight year old whale (#353), not previously known to be female, was seen for the first time with a calf this season in Icy Strait, making her the first known age whale in the study area to return with a calf. One yearling whale, (#1057) returned for the first time since separating from its mother, making it the youngest returning calf that has been documented in the study area.

INTRODUCTION

This report summarizes the humpback whale population monitoring effort in the waters of Glacier Bay and and Icy Strait, southeastern Alaska, during the late spring and summer of 1992. Humpback whales migrate each year between summer coastal feeding grounds in high latitudes and winter breeding and calving grounds near islands or shallow banks in low-latitude waters (Baker et al. 1986). Known feeding areas in the eastern North Pacific occur along the rim of the Pacific basin from central California to the Aleutian Islands. Northern hemisphere humpbacks appear to form several geographically-isolated summer 'feeding herds' that congregate in low-latitude waters in winter (Baker et al. 1986; 1990a; 1990b; Katona and Beard 1990). Mark recapture methods estimate that 547 humpback whales (95% confidence limits 504 to 590) visited southeastern Alaska between 1979 and 1986 (Baker et al. 1990a). The whales that use Glacier Bay and Icy Strait are considered to be part of thesoutheastern Alaska feeding herd.

Humpback whales have been known to inhabit Glacier Bay since at least the 1930's (Vequist and Baker 1987). The amount of vessel traffic in the bay has consistently increased throughout the twentieth century, undergoing a dramatic increase in the 1970's. Humpback whale studies began in Glacier Bay in the early 1970s, when Jurasz and his associates began identifying individual whales by their natural markings (Jurasz and Palmer 1981). In 1978, 17 of the 20 whales that Jurasz observed in Glacier Bay departed abruptly (Jurasz and Palmer 1981). Some investigators inferred that the whales had left because the level of vessel traffic had become intolerable. Others hypothesized that the whales' departure was best explained by a natural decline in the availability of their prey. Insufficient evidence with which to evaluate these hypotheses existed at that time. In 1979, the National Park Service (NPS) requested consultation with the National Marine Fisheries Service (NMFS) under section VII of the Endangered Species Act, in order to formally address these concerns.

The consultation with the NMFS resulted in a Biological Opinion 1979, which recommended that the NPS take the following actions: 1) regulate the number of vessel entries into Glacier Bay; 2) restrict vessels from approaching and pursuing whales in Glacier Bay; and 3) conduct studies in Glacier Bay and southeastern Alaska to characterize whale food and feeding behavior, the effects of vessels on whale behavior and the underwater acoustic environment. The NPS took the recommended actions by enacting regulations to prohibit whale approach, regulate vessel numbers and operations in Glacier Bay (Federal Register 45 32228, May 15, 1980), and by initiating the recommended studies.

The acoustic and behavioral studies demonstrated the influence of vessel presence on underwater noise and the movement and respiration of whales (Baker et al. 1982; Baker et al. 1983; Baker and Herman 1989; Malme, Miles and McElroy 1982; Miles and Malme 1983). The whale-prey studies demonstrated seasonal and annual variation in whale prey type and abundance in Glacier Bay and other parts of southeastern Alaska (Wing and Krieger 1983; Krieger and Wing 1984; Krieger and Wing 1986). In summary, the studies corroborated some aspects of each hypothesis for the whales' 1978 departure, and neither hypothesis was rejected. Integrating historical whale counts and the early results of the scientific studies, a second Biological Opinion was issued by the NMFS in 1983 (Federal Register 49 15482, April 18, 1984)

The 1983 Biological Opinion requires that the NPS continue to monitor whale numbers in Glacier Bay from June 1 to August 31 each year, and recommends a rationale for regulating vessel numbers in the bay. Those regulations were enacted in the summer of 1985 (CFR 36 13.65), and are subject to annual review and modification at the discretion of the superintendent of Glacier Bay National Park. Glacier Bay National Park is in the process of writing and enacting a Vessel Management Plan which could substantially change the number of vessels that enter Glacier Bay each summer. As part of the Vessel Management Plan process, consultation between the NMFs and the NPS was re-initiated in August 1992, and a third Biological Opinion is anticipated.

Humpback whale population monitoring, initiated in 1985 by the NPS, is intended to provide the NPS and the NMFS with the necessary information to manage humpback whale populations in Glacier Bay and southeastern Alaska. Under this monitoring program, data have been collected in a systematic fashion with similar amounts of effort each year, to ensure comparability between annual counts. These studies have revealed considerable variability in the number of whales using Glacier Bay (summarized in Gabriele 1991) and demonstrate a great deal of interchange between Glacier Bay and Icy Strait within and between years (Perry et al. 1985; Baker 1985, 1986, 1987; Baker and Straley 1988; Straley 1989, 1990; Gabriele 1991). Subsequent studies have also shown exchange between Frederick Sound and Glacier Bay/Icy Strait, (Baker et al. 1990, Baker et al. 1986), suggesting that the number of whales in all of these areas is interdependent. Studies of the availability of whale prey in and around Glacier Bay continue to be important to an understanding of the movements of whales in southeastern Alaska. The systematic studies of individually-identified humpback whales in Glacier Bay, funded by the NPS, now constitute one of the longest and most complete time-series of data on a living baleen whale population (Jurasz and Palmer 1981; Perry et al. 1990).

METHODS

Vessel Surveys: The 1992 humpback whale monitoring program concentrated in Glacier Bay and Icy Strait from mid-May to the end of August. Humpback whales were observed and photographed from a 17' Boston Whaler powered with a 60 hp outboard engine. Surveys were conducted in Glacier Bay and Icy Strait. The main body of Glacier Bay (a rectangle defined by four corners: Bartlett Cove, Point Carrolus, Geikie Inlet and Garforth Island) was usually surveyed three days per week. Surveys were not conducted in the same area on consecutive days in order to minimize the potential impact that monitoring efforts may have upon the whales. On occasions when circumstances such as time, weather or the presence of other vessels prevented whale identification photographs from being taken, consecutive surveys of the same area were made. Surveys of the upper bay were conducted approximately bi-weekly or when whale sightings were reported by tour vessels. Upper bay surveys extended as far north as the north end of the Gilbert Peninsula in the West Arm and Nunatak Cove in the East Arm. Icy Strait surveys were performed approximately once per week, with the greatest survey effort along the shoreline of Chichagoff Island, from Mud Bay to Eagle Point. Surveys of the north and west shorelines of Pleasant Island were also conducted as time and weather permitted. Icy Strait surveys also resulted in a survey of the mouth of Glacier Bay, because that area is crossed in transit from Bartlett Cove to Icy Strait. Table 1 shows the number of surveys which were conducted in Glacier Bay and Icy Strait in 1992 and previous years. Table 2 shows 1985-1992 survey effort in terms of hours of search and observation time.

Individual identification: Whale fluke photographs were taken with a Nikon 8008 camera equipped with a motordrive and a 300 mm lens. High speed (400 ASA pushed to 1600) black and white film was used to obtain clear photographs of the ventral fluke surface of each whale. Each whale fluke has a distinct black and white pigment pattern that allows for individual identification (Katona et al. 1979). Photographs of the dorsal fin contributed to the identification of individuals. The film was processed and printed by Panda Lab in Seattle, Washington. Contact sheets were used for preliminary data analysis. The season's best photograph of each individual was printed and catalogued. A copy of each print was submitted to the North Pacific humpback whale database at the National Marine Mammal Laboratory (Mizroch, Beard and Lynde 1990).

Photographs of individuals were compared to previous Glacier Bay photographs and to available catalogs (Jurasz and Palmer 1981; Perry et al. 1985; Perry et al. 1988; von Zeigesar 1992) to determine the identity and past sighting history of each whale. Many whales are referred to by an identification number issued by the Kewalo Basin Marine Mammal Laboratory (KBMML) catalog of North Pacific humpback whales (Perry et al. 1988). Whales first photoidentified by Jurasz and Palmer (1981a; 1981b) are also listed by their nicknames. Identification numbers smaller than ID# 950 coincide with those in the KBMML catalog, but those ID#s greater than 950 are unique to the Glacier Bay

Table 1.

Number of humpback whale survey days per month in Glacier Bay and Icy Strait, 1985-1992.

	Glacier Bay					Icy Strait				
	MAY	JUNE	JULY	AUG	SEPT	MAY	JUNE	JULY	AUG	SEPT
1992	3	19	17	12	7	2	4	5	4	1
1991	7	14	17	13	6	3	7	6	4	3
1990	6	16	18	14	0	4	5	6	8	0
1989	3	17	14	16	1	1	6	6	7	4
1988	0	11	12	12	7	0	5	7	5	3
1987	3	12	12	5	1	2	5	7	7	2
1986	0	13	17	6	0	0	5	3	6	2
1985	0	10	11	10	0	0	7	4	3	1

Table 2.

Total search and encounter time in Glacier Bay (GB) and Icy Strait (IS): 1985 and 1988-92.

year	GB (hrs)	IS (hrs)	Total (hrs)	Total Whale Count (GB and IS)
1992	248	71	319	68
1991	256	100	356	52
1990	215	115	330	50
1989	231	123	354	42
1988	199	108	307	55
1987	-	-	-	59
1986	-	-	-	51
1985	234	92	326	41

catalog. Whales that were previously unidentified in Glacier Bay and Icy Strait were assigned a temporary identification code, for example AGB 92-01, indicating the year and location of the sighting. Temporary codes were replaced with permanent identification numbers if the whale was seen more than once in a season, or if it had been identified elsewhere or in previous years.

Whale Counts: After all the photographs had been analyzed, a count was made of the number of distinct individual whales in the sample. Separate counts were made of Glacier Bay and Icy Strait, for the total monitoring period and for a 'standardized period' (after Perry et al. 1985), from 9 July to 16 August. The standardized period was chosen by Perry and co-workers (1985), to coincide with the study dates in 1982-1984, so that valid comparisons of counts between years could be made. Although the standardized period is substantially shorter than the current NPS monitoring season, and the beginning and ending dates have no particular biological significance, the standardized counts tend to reflect the total counts relatively well (see Table 3). Continued use of the 'standardized period' is currently the only way of comparing whale counts over the entire systematic data collection period of 1982-1992.

Prey Assessment: No systematic effort to monitor humpback whale prey was made in 1992.

RESULTS

Counts. A total of 68 individual humpback whales were photographically identified in Glacier Bay and Icy Strait between 20 May and 2 September 1992 (Table 3; Appendix A). Of this total count, 18 (26.5%) whales were common to both areas. A number of whales (33, including 7 cow/calf pairs) were sighted exclusively in Icy Strait with 17 (including 2 cow/calf pairs) observed exclusively in Glacier Bay. Limiting the count to only those whales seen during the standardized period (Perry et al. 1985), yielded a standardized count of 27 (including 4 cow/calf pairs) whales in Glacier Bay and 38 (including 7 cow/calf pairs) in Icy Strait. For Icy Strait and Glacier Bay combined, there were 51 whales observed during the standardized period. Table 3 shows the numbers of whales identified during standardized and entire monitoring periods from 1982-1992. The 1992 standardized and total counts for Glacier Bay are the second highest since 1982. The Icy Strait counts for 1992 are the highest recorded since 1982. Figure 1 shows a comparison of the combined Glacier Bay/Icy Strait whale counts from 1982-1992.

Many whales that were identified this summer are individuals that demonstrate strong fidelity to the Glacier Bay/Icy Strait region. At least fifteen of the whales that were sighted in 1992 were first documented in this area in the mid-1970's (Jurasz and Palmer 1981). All of these individuals have been identified in the area in most or all of the subsequent years (Perry et al. 1985; Baker 1986, 1987; Baker and Straley 1988; Straley 1989, 1990; Gabriele 1991). One individual whale (#1011) has been identified in the study area in 1989, 1991 and 1992 in the late season only, never earlier than September. In 1992, five whales were identified that have not been sighted in the study area in previous years. Three other individuals (#397, #504 and #817) are known from sightings in Frederick Sound and other regions in southeastern Alaska, and are rarely sighted in the Glacier Bay/Icy Strait area.

Table 3.

Standardized and total counts of individually-identified humpback whales in Glacier Bay and Icy Strait.

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Glacier Bay											
std	22	10	24	10	26	28	17	20	16	16	27
total	22	10	25	15	32	33	39	24	26	19	35
Icy Strait											
std	5	9	21	19	27	34	29	19	24	34	38
total	15	9	22	30	35	48	36	30	34	40	51
Glacier Bay and Icy Strait Combined											
std	33	17	39	27	42	49	41	33	36	45	51
total	33	17	39	41	51	59	55	42	50	52	68

Note: Total counts refer to the number of whales (adults and calves) identified during the entire monitoring season. Standardized counts refer to the number of whales sighted between 09 July and 16 August each year. The combined count for Glacier Bay and Icy Strait is typically slightly less than the sum of Glacier Bay and Icy Strait counts, because some whales are identified in both areas.

Seasonal Distribution: Figure 2 illustrates the timing of whale use of Glacier Bay and Icy Strait in 1992. As shown, few whales were present in Glacier Bay during May and the first half of June. The highest numbers of whales were present in Glacier Bay in mid-July to mid-August, coinciding with the standardized counting period, when 20-25 whales were present. In August, whale use of the bay declined gradually, leaving approximately 5 whales in the bay in September. The largest number of whales identified on one day in Glacier Bay was 13, on August 4 and 6. Icy Strait whale numbers followed a similar progression as Glacier Bay, with a somewhat more abrupt early-season rise and August decline. The highest number of whales identified in a single Icy Strait survey was 23, on July 8.

Figure 3 shows the approximate locations of Glacier Bay and Icy Strait whale sightings during the 1992 study. Glacier Bay whale sightings occurred throughout the bay, but tended to be further north early in the season and then heavily concentrated in the lower bay in July and August. In early July, at least 4 different whales were consistently sighted in the mouth of Muir Inlet, primarily whales #1063 and #117, but by late July, both of these individuals had been sighted elsewhere in Glacier Bay. Icy Strait whale activity concentrated at Point Adolphus throughout the summer, although sightings were recorded along the coastline from Mud Bay to Eagle Point.

Local Movement and Residency: The 1992 season was characterized by a great deal of whale movement between Glacier Bay and Icy Strait. Eighteen different whales (26.5% of all identified whales) were sighted in both Icy Strait and

Glacier Bay. See Appendix A for the complete sighting records of each whale. Whale #118 made at least 3 round trips between Icy Strait and Glacier Bay, apparently using both areas simultaneously. Figure 4 shows the approximate residence times of whales in Glacier Bay and Icy Strait. One assumption that was made in calculating residence times is that a whale was present in the area where it was sighted throughout the interval between sightings of that whale. Whales that moved between Glacier Bay and Icy Strait were presumed to have moved between those areas at the midpoint of the interval between the last sighting in one area and the first sighting in the other area. Eighteen (51.4%) of the whales that entered Glacier Bay remained 20 or more days, long enough to be considered residents (after Baker et al. 1983). Using the same residency criterion, 28 (54.9%) of the 51 Icy Strait whales were considered resident in that area during the study.

Feeding Behavior: Based on information from previous studies, the primary prey item available to Icy Strait whales is thought to be herring (*Clupea harengus*) (Wing and Kreiger 1983; Kreiger and Wing 1984, 1986). Similarly, the primary whale prey items in Glacier Bay are believed to be schooling fish such as capelin (*Mallotus villosus*) and sand lance (*Ammodytes hexapterus*)(Kreiger and Wing 1984, 1986).

Humpback whale feeding behavior in Glacier Bay is typically characterized by solitary, sub-surface browsing. In 1992, as in previous years, many whales foraged alone, and sightings of pairs and trios of adults were common. However, in contrast to most other years, there were frequent observations of groups of 3-6 whales in Bartlett Cove and Sitakaday Narrows in July and August. The whales that were most often found in the lower bay group were #577, #161, #564 and #1047, and joined on one or more days by #535, #235, #221 and #351. Lunge feeding was observed infrequently in Glacier Bay, a few times in the mouth of Bartlett Cove and on one occasion in Beardslee Entrance.

Many whales in Icy Strait foraged alone or in small groups, as described in previous years (Baker 1986, 1987; Perry et al. 1985; Straley 1989, 1990). However, coordinated feeding by larger groups of whales was also observed at Point Adolphus on most survey days. On July 8 and July 23, the group consisted of 15-20 whales. On many occasions, the members of the large group were individuals that are typically found in a stable association (Perry et al. 1985). Three females, each accompanied by a calf (#587, #530, #155, #353), were intermittently present in the large groups, which is uncommon but has been documented in previous years (Baker 1985; Straley 1989, 1990).

Reproduction and Juvenile Survival: Twelve different cow/calf pairs were identified in the study area in 1992. Two cow/calf pairs were sighted exclusively in Glacier Bay, seven were sighted exclusively in Icy Strait, and two were sighted primarily in Icy Strait but were present in Bartlett Cove on one day (#587, #219). One female (#566) and her calf were sighted once in Icy Strait and once in Glacier Bay. Table 4 lists the identified cows and calves in 1992. In addition to the seven photographically-identified calves of known mothers, three additional calf fluke photographs were obtained from calves that were not closely accompanied by an adult. It is likely that these three calves (#IS92-17, #1066 and #IS92-8) are the offspring of the five females known to be with a calf this season but whose calves were not identified (#587, #155, #941, #IS92-1, #817). Without subsequent sightings that allow the identities of cow and calf to

be linked, it is impossible to ascertain the identity of the mothers of these calves. It is possible that the three calves belonged to females in the area that were not known to be with a calf this year.

Two notable events are shown in Table 4. The first is that female #193 has been accompanied by a different calf in the past three consecutive summers (Gabriele 1991; Straley, Gabriele and Baker in prep.). Calving in two or more consecutive years is unusual in humpback whales (Glockner-Ferrari and Ferrari 1990; Clapham and Mayo 1987; Baker, Perry and Herman 1987), but has been documented in two other females in the study, #235 and #581 (Baker, Perry and Herman 1987; Baker and Straley 1988; Straley 1989).

Table 4.

Females Accompanied by a Calf in 1992

Mother ID#	Calf ID#	Location	Year of Most Recent Known Calf
1. 353	1072	IS	none
2. 193	1069	IS	1991
3. 587 Gertrude	.	IS/GB	1988
4. 566 Curly Fluke	1068	IS/GB	1989
5. IS92-1	.	IS	unknown
6. 530	1067	IS	1990
7. 236 Leigh	1064	GB	1989
8. 941	.	IS	1988
9. 219	1070	IS/GB	1990
10. 155 Freckle Fluke	.	IS	1990
11. 817	.	IS	unknown
12. 801	1065	GB	1990

Note: Calves with no ID# are those for which no fluke photograph was obtained.
GB= Glacier Bay, IS = Icy Strait

Another interesting observation in 1992 was the first known reproduction by whale #353, (born to #530 in 1984), not previously known to be female. Calf #1072, the offspring of #353, is the first third generation calf in the Glacier Bay/Icy Strait area. At eight years of age, #353 is somewhat older than the typical age at first reproduction of 4-7 years (Clapham 1992). Whale #353 has been sighted repeatedly in the study area in each of the past 5 summers, unaccompanied by a calf, making it unlikely that she was with an undetected calf in the study area. Because her sighting record is complete, it seems equally unlikely that she raised a calf in a location outside of the study area. It is possible that #353 gave birth in one or more previous years to a calf that did not survive the migration to the feeding grounds. The rate of neonatal and juvenile mortality, although not yet quantified for this population, is believed to account for discrepancies between calving rates observed on breeding and feeding grounds (Baker et al. 1987, Clapham and Mayo 1987).

A one-year old whale, #1057, was observed in Icy Strait in late May. Whale #1057 was first identified as the calf of #539 in 1991 (Gabriele 1991). Other individuals that were first observed as calves, and subsequently returned to the

area were also sighted this year. Among the more recent returnees, whale #1042 returned to Icy Strait for the third summer since its birth year, and whale #1014 was sighted in Glacier Bay for the second consecutive year since it separated from its mother (#236).

The crude birth rate (CBR), computed by dividing the number of calves by the total number of whales, provides a measure of the reproductive rate for the local population. Table 5 shows the crude birth rate for the years 1982-1992, and illustrates that the 1992 figure is among the three highest observed for the study population.

Table 5.

Crude birth rates for humpback whales in Glacier Bay and Icy Strait, 1982-1992

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
# Whales	33	17	39	41	51	59	55	42	50	52	68
# Calves	6	0	7	2	8	4	8	5	6	4	12
CBR	18.2%	0%	17.9%	4.5%	15.7%	6.8%	14.5%	11.9%	12.0%	7.7%	17.6%

Note: #Whales = total number of Glacier Bay and Icy Strait whales (including adults and calves), #Calves = number of calves, CBR = crude birth rate, a percentage computed by #C/#W.

Whale/Vessel Interactions: Peak numbers of vessels in Glacier Bay (NPS files) coincided with peak numbers of whales (Figure 2), increasing the probability of whale/vessel interactions, especially in the lower bay where whale densities were highest (Figure 3). One collision between a whale and a vessel was reported in Icy Strait at Point Adolphus. A video tape of the incident, made by a Glacier Bay Lodge tour boat operator, is in the GLBA Ranger Division files. It is unknown whether the calf was injured or killed by the collision, as a number of whales that were present at Point Adolphus prior to the incident were not present in subsequent surveys of the area. The departure of whales from the area is not believed to be related to the collision. No entanglements of whales in fishing gear were reported or observed in Glacier Bay or Icy Strait.

DISCUSSION

The 1992 season was characterized by relatively high numbers of whales in the study area and a great degree of whale movement between Icy Strait and Glacier Bay. In some places, specifically the lower bay and Point Adolphus, foraging whales formed large, somewhat stable groups, primarily during the month of July. The occurrence of large groups of whales in Glacier Bay, as observed this season, is uncommon but was also observed in 1982 and 1986

(Baker 1986). Most of the regular inhabitants of the Glacier Bay/Icy Strait were present for the bulk of the study period, and some other whales were observed to visit the area briefly in July (Figure 4, Appendix A).

The study that is the subject of this report was initiated due to concern over the potential effects of human disturbance on humpback whales. The short-term effects of vessel traffic on behavior have been documented in a number of whale species, (e.g. Baker and Herman 1989; Richardson et al. 1985), but the long term effects on reproduction and distribution are largely unknown. Our ability to discern the effects of human disturbance on humpback whales in Glacier Bay is thwarted by our limited understanding of the non-human factors that affect the species' distribution. However, in our attempts to arrive at a scientific understanding of this complex system we have failed to hold constant the one variable that is subject to human volition, the level vessel traffic. Even with the limitation of constantly changing levels of human intervention, long-term population monitoring may still enable us to assess and predict potential cyclic changes in whale distribution.

Each season's worth of whale observations can be characterized by a number of variables, including the number of whales identified, their spatial and temporal distribution, foraging behavior, degree of exchange between Glacier Bay and Icy Strait and the proportion of cow/calf pairs. Comparisons of the humpback whale monitoring reports from 1985 to 1992 suggests that some pairs of years are more similar than others with regard to these characteristics, and that there are patterns that repeat themselves on multi-year cycles. A promising next step toward a better understanding of whale distribution in and around Glacier Bay would be to generate and analyze a matrix of yearly whale population characteristics in order to discern the time scale and attributes of cyclic changes. Although we have some grasp of the underlying factors that govern biological cycles in the Glacier Bay ecosystem, they are at present poorly understood. Although it seems self-evident that whale distribution within the study area and in southeastern Alaska as a whole is largely dictated by prey availability, we lack the consistent and thorough data on zooplankton and schooling fish necessary to fully understand the factors in this relationship. Much work remains to be done on long-term assessment of prey characteristics in Glacier Bay and southeastern Alaska. Studies of schooling fish and zooplankton in the study area should be expanded by the NPS, in cooperation with the NMFS, because these are essential to an understanding of whale behavior, foraging patterns, abundance and seasonal distribution.

There has been considerable variability in the number of whales observed in the study area during the past decade, with several large oscillations in whale abundance (Table 3, Figure 1). For example, the Glacier Bay counts in the contiguous years 1991 and 1992 are among the lowest and the highest (respectively) counts made over the eleven years of the study. Since it is highly unlikely that the increase from 1991 to 1992 in Glacier Bay represents population growth, it is clear that whale abundance in Glacier Bay must be viewed relative to that of Icy Strait and other parts of southeastern Alaska. The increase in Glacier Bay counts cannot be solely attributed to an influx of whales from Icy Strait because Icy Strait counts have increased for the third consecutive year (Table 3). Movement between Frederick Sound and Glacier Bay/Icy Strait has been documented previously (e.g. Baker et al. 1990), and as noted earlier, three whales that had previously been identified primarily in Frederick Sound were sighted in the study area.

Another of the main features of the 1992 season was the presence of twelve calves. Nine out of the twelve cows with a calf in 1992 were females that are routinely sighted in the study area (Perry et al. 1985; Baker 1986, 1987; Baker

and Straley 1988; Straley 1989, 1990; Gabriele 1991). Although these calves account for a significant proportion of the 1992 whale count (17.6%, see Table 5), their existence may tell us indirectly about the whale prey abundance in 1990. Moss (1988) proposed that the body condition of female African elephants (*Loxodonta africana*), determined by savannah drought cycles, was a mechanism for determining the occurrence of ovulation. If, as in the African elephant, humpback whale conception is influenced by the condition of the mother, the summer before these females conceived, (in this case summer 1990), was probably sufficiently good for many females to breed successfully in winter 1991. It would not be surprising if female humpback whales, who exist in a fluctuating environment and make large energetic commitments to gestation and lactation, choose carefully the years that they attempt to reproduce. The most pertinent analysis to address this hypothesis would be to examine reproductive synchrony among females, and synchrony with environmental variables, but this has yet to be done. The characteristics of the lifetime reproductive success of the females in the study area are as yet unknown, but are integrally related to the long-term projections for the local population.

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Figure 1.
Total and Standardized Counts in Glacier Bay: 1982-1992

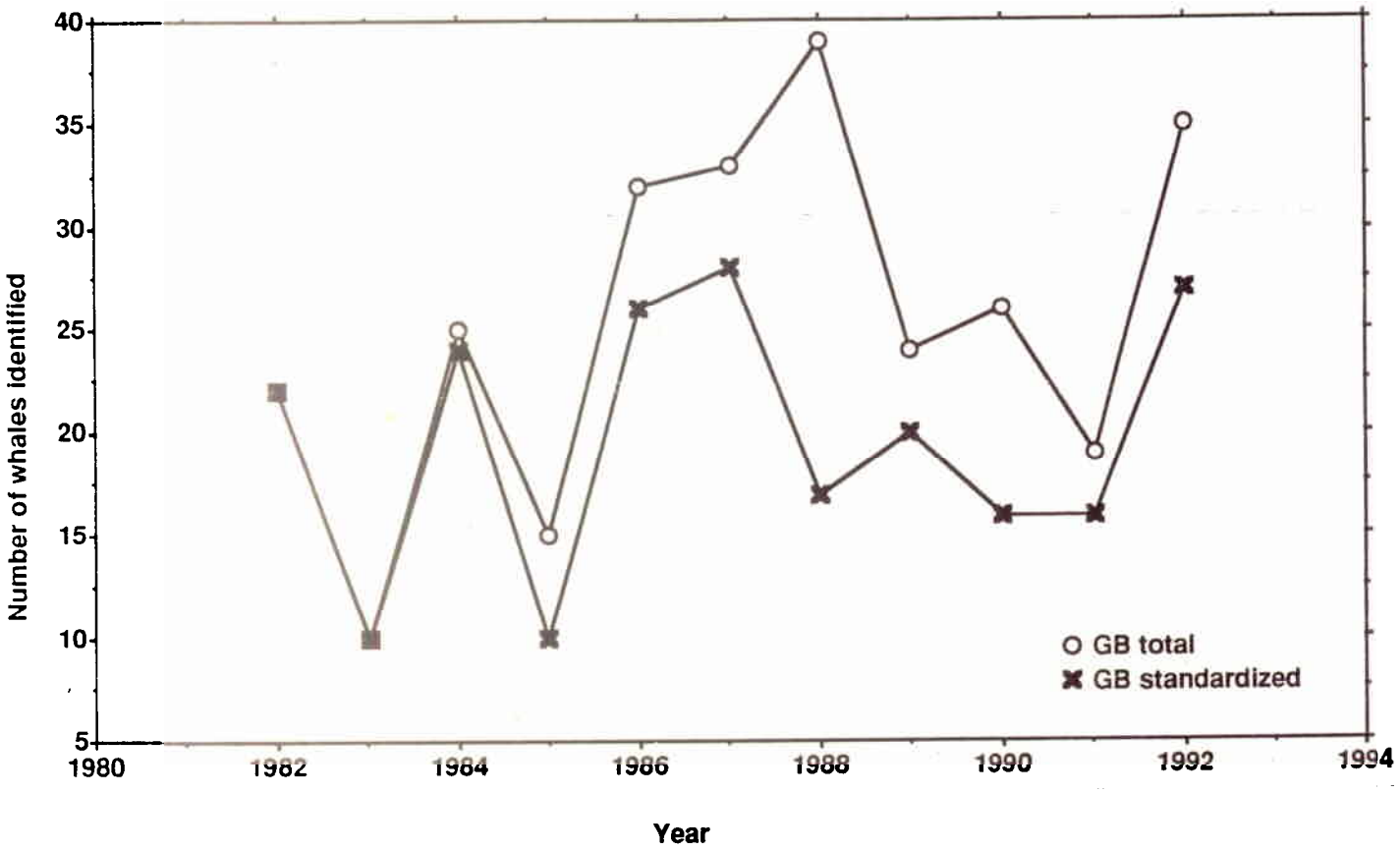
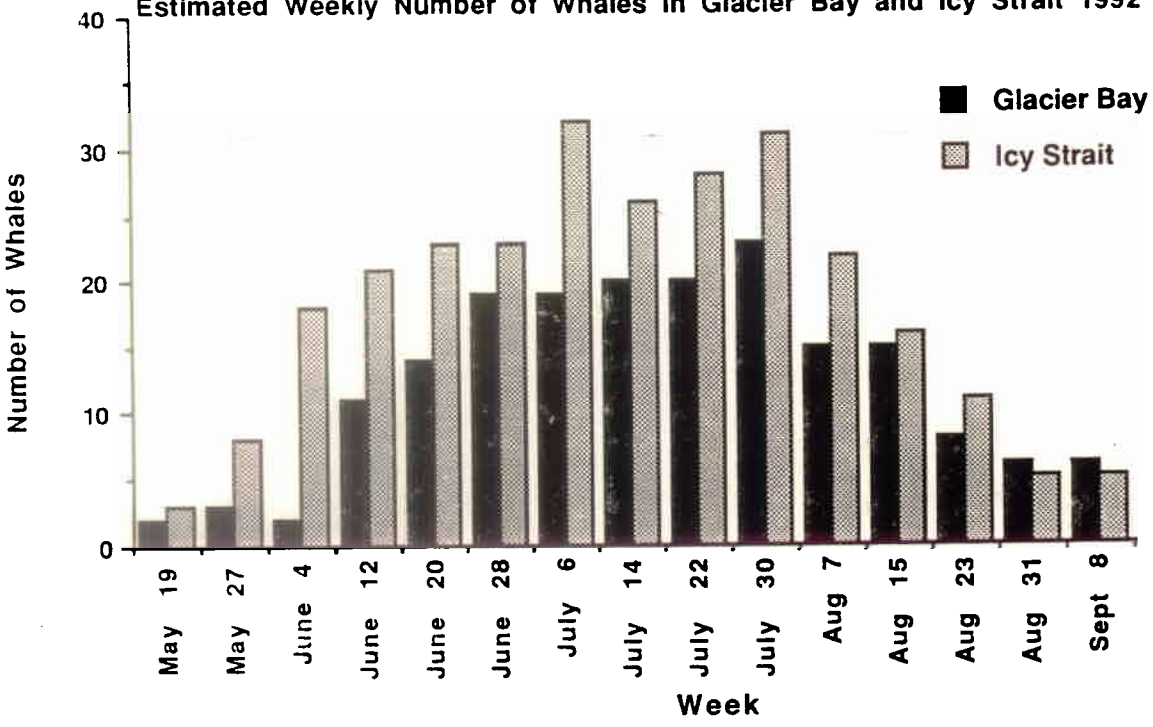


Figure 2.
Estimated Weekly Number of Whales in Glacier Bay and Icy Strait 1992



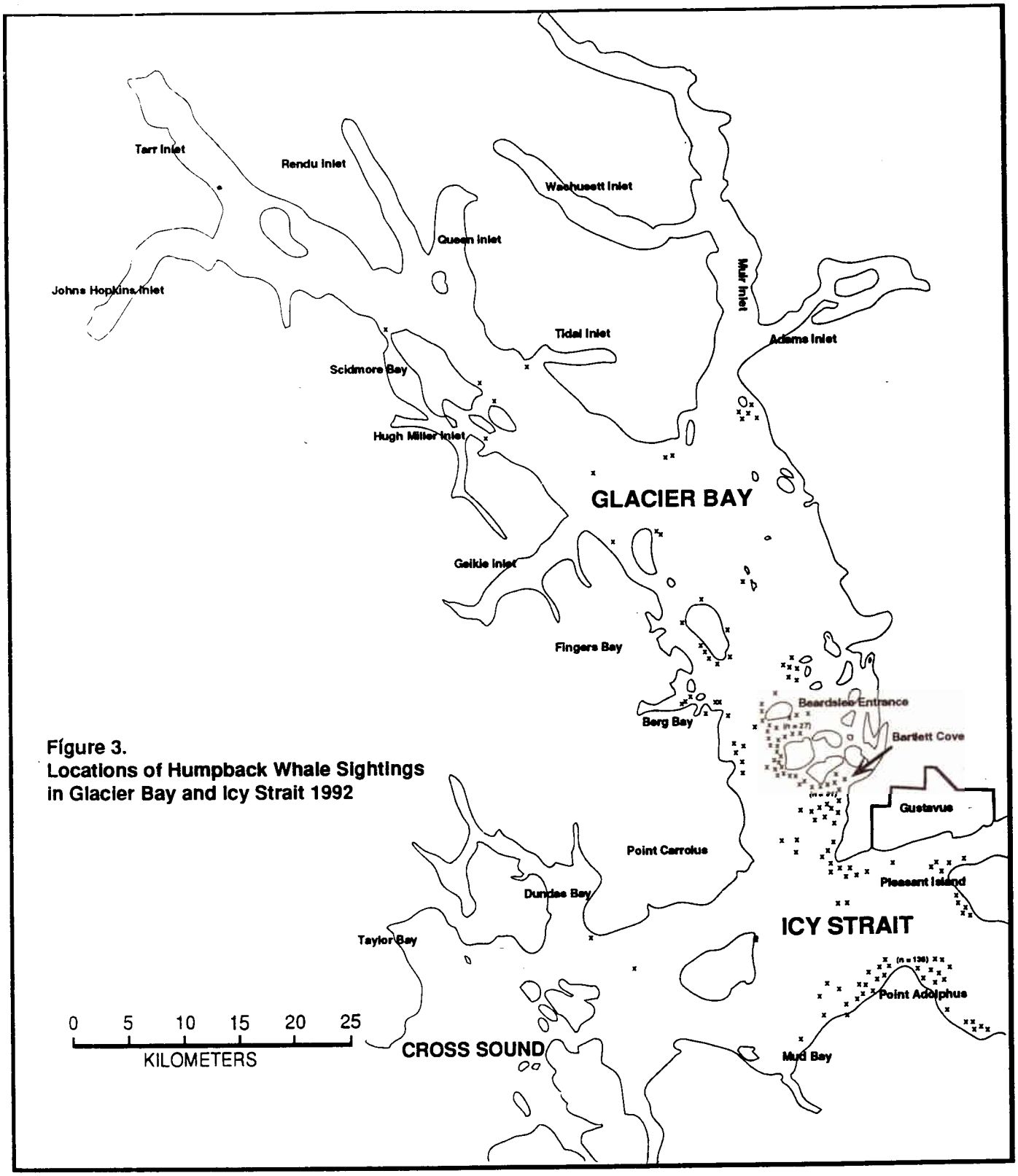
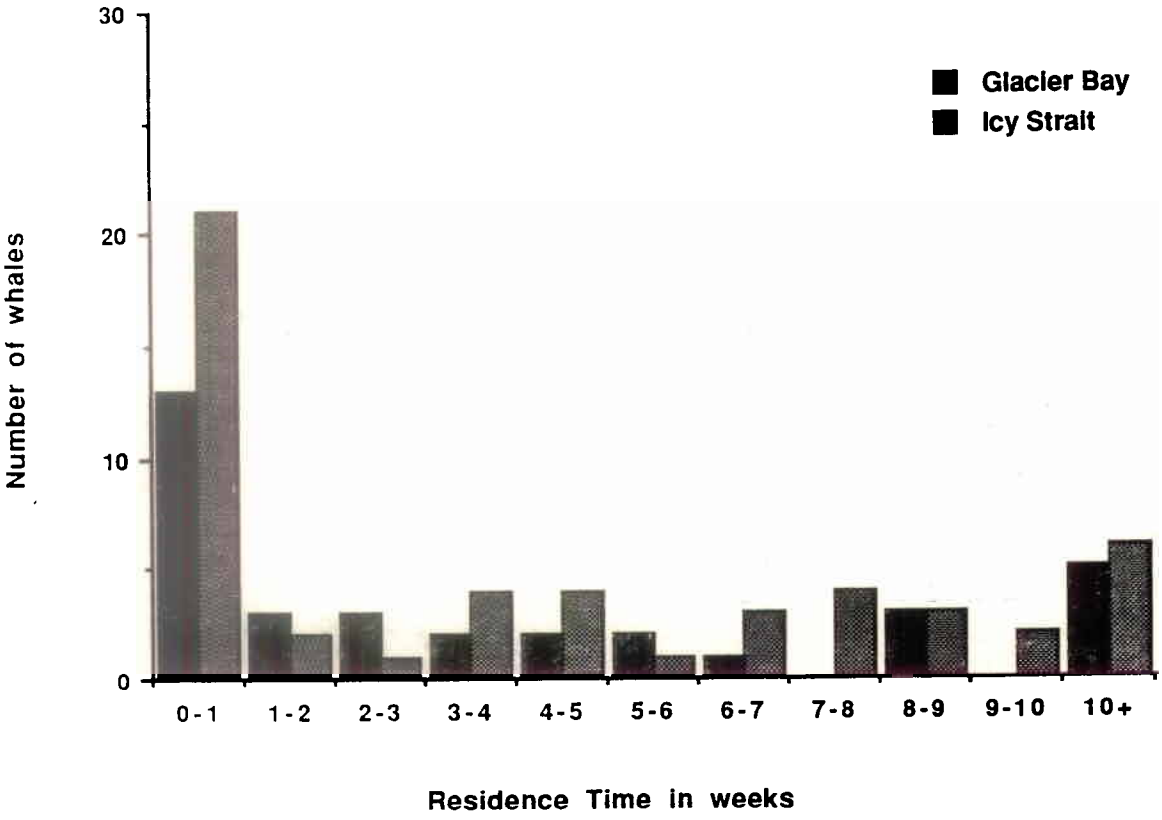
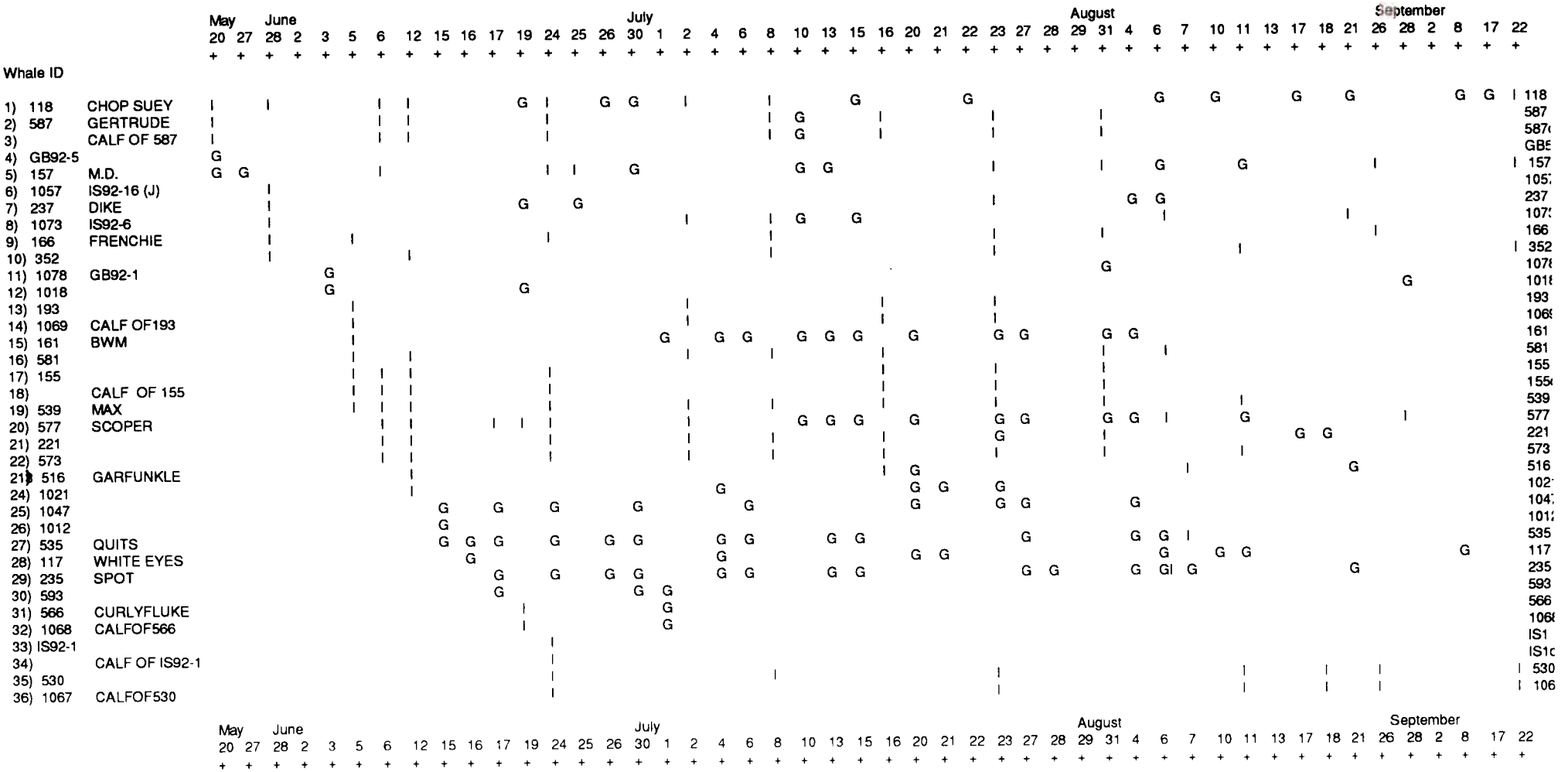


Figure 3.
Locations of Humpback Whale Sightings in Glacier Bay and Icy Strait 1992

Figure 4.
Estimated Residence Times of Whales in Glacier Bay and Icy Strait 1992

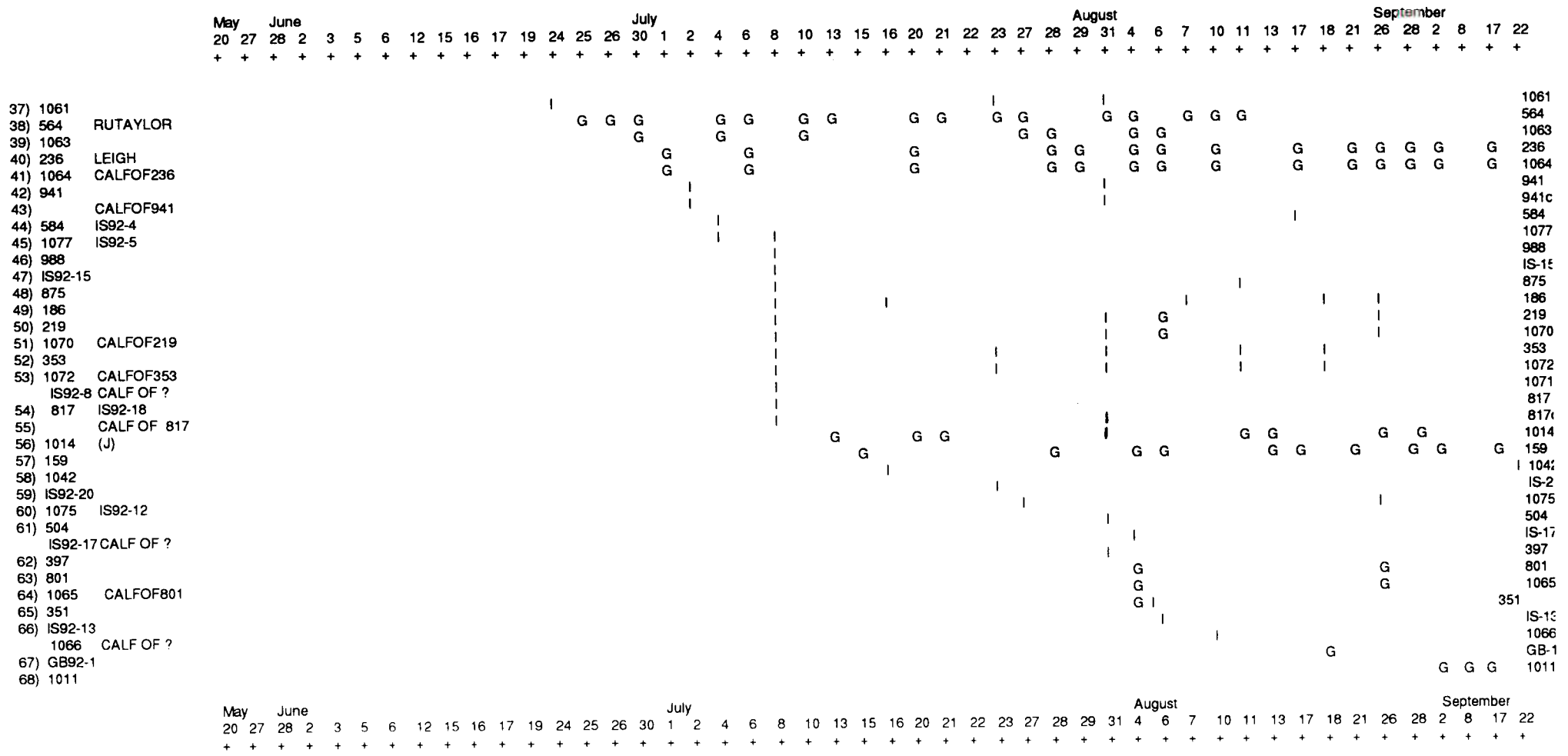


APPENDIX A. **HUMPBACK WHALE SIGHTING HISTORIES 1992**



NOTE: J = JUVENILE KNOWN TO BE LESS THAN FIVE YEARS OF AGE.

APPENDIX A. **HUMPBACK WHALE SIGHTING HISTORIES 1992 (continued)**



NOTE: J = JUVENILE KNOWN TO BE LESS THAN FIVE YEARS OF AGE.